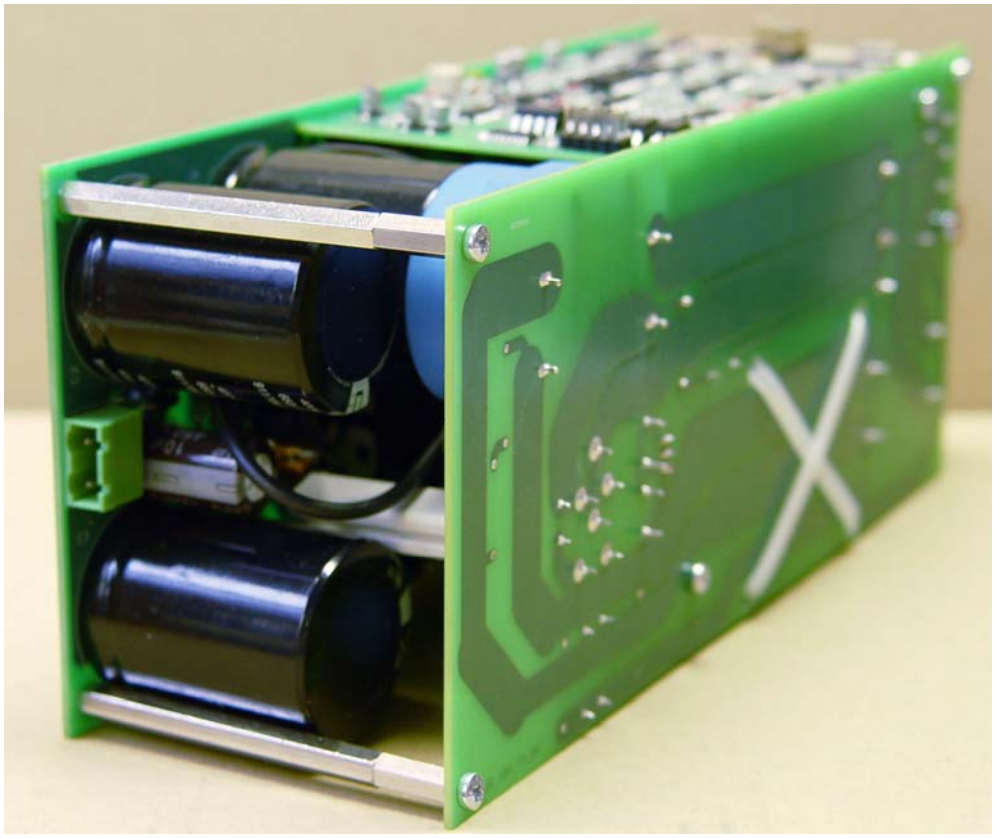
User Manual



PM3K350

Bidirectional 3.5 kW DC/DC Converter Module

FLEXIVA®
automation & Robotik

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Preface

The present Technical Documentation is to inform of the correct operation of the DC/DC converter modules PM3K350. The modules serve to convert direct voltages in a bidirectional way.

The operating manual is to be preserved.

It is prohibited to copy or duplicate texts, plans, and tables or to make them accessible to any third parties without our express consent.

We draw your attention to the fact that the Technical Documentation shall not be part of an existing earlier agreement or promise or part of a legal relationship.

All and any obligations result from the purchase contract that also solely contains the warranty determination. The contractual provisions shall not be affected by the Technical Documentation.

The documentations of the suppliers used shall apply along with the present documentation of the manufacturer.

In addition to the operating manual, all universally valid legal and other obligatory regulations concerning the prevention of accidents and the environmental protection are to be complied with and to be instructed.

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1 Introduction

In order to guarantee the safety of the operator and to avoid possible damages at the module, you have to ensure by all means that the present user's manual has been read completely before starting to use the module and/or the plant connected with it.

The present user manual is to help you to get to know the DC/DC module better and to enable you to use it according to the intended working possibilities.

Prior to the commissioning, the operating staff has to familiarize itself with all sub-units and their functions. Particular attention is to be paid to the paragraph safety.

The present user manual contains important information on the correct and economical application of the DC/DC module. The compliance with these instructions contributes to the fact that dangers are avoided, costs owing to repairs and breakdown times are reduced, and the service life of the module is prolonged.

A symbol is provided at the text margin in the chapters if required that refers to the function of the respective text section and is of importance with regard to the operation or the maintenance and/or indicates important descriptions or notes:

Danger

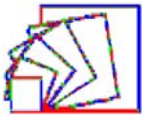
All sections in the manual containing information on possible dangers are marked with the marginal symbol.
The non-observance can lead to serious injuries! The instructions are to be strictly complied with.

Attention

All sections with this symbol provide instructions how to avoid damages at the unit.

Advice

Sections with this symbol give important details for an efficient work.



The work steps that are described in logical order at the side of this symbol inform the operator of the most ergonomic proceeding of the operation.

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2 Identification

2.1 Product Trademark and Type Designation

ZEMIS® PM3K350

2.2 Product Version / Version of Software / Editing State

Product Version: PM3K350-00

Firmware: 01.05

State: 2012

2.3 Declaration of Conformity with the Product Standards

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EG-KONFORMITÄTSERKLÄRUNG

Hiermit erklären wir, dass das nachfolgend bezeichnete Produkt aufgrund seiner Konzipierung und Bauart sowie in der von uns in Verkehr gebrachten Ausführung den einschlägigen EG-Richtlinien entspricht.

Die EG-Konformitätserklärungen unserer Lieferanten werden von uns zur Verfügung gehalten und können jederzeit eingesehen werden.

Bei nicht mit uns abgestimmten Änderungen an dem Gerät oder nicht bestimmungsgemäßen Eingriffen verliert diese Erklärung ihre Gültigkeit.

Bezeichnung des Produktes : DC/DC-Wandler-Modul (für den Einbau bestimmt)

Typenbezeichnung : PM3Kxxxx

Einschlägige EG-Richtlinien:

- EG-Richtlinie betreffend elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen, „Niederspannungsrichtlinie“ (72/23/EWG)

Angewandte harmonisierte Normen, insbesondere:

- EN 60950-1:2006
  Einrichtungen der Informationstechnik - Sicherheit – Teil 1: Allgemeine Anforderungen

Unterschrift
Hersteller oder Errichter
Der Anlage/des Betriebsmittels

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TÜV

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3 Product Description

3.1 General Information / Utilization as Directed

The DC/DC converter module serves to couple various sources, acceptors, and storing elements of electric energy with each other by means of a DC link that have absolutely different ranges of operating voltages between 0V and 350V. If offers a high efficiency, a flexible control as well as a digital interface. Because of the DC link voltage of 375V, a simple coupling of a 230V AC system is possible.

Attention

The PM3K350 module does not offer any galvanic isolation of DC link and output! In case of the interconnection with other modules without galvanic isolation, this can lead to the damaging of the PM3K350 module.

Terms and abbreviations

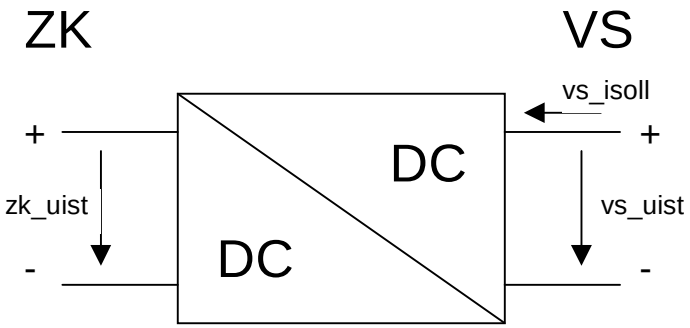

Fig. 1: Principle

DC link:	DC link – this is the designation for the side of the module by means of which the coupling with other DC/DC modules or the link of any other 380V DC component (e.g. inverter) can be carried out.
Variable voltage:	Variable voltage – this is the designation for the side of the module to which the components are connected. The designation output is also used but it is not quite correct because of the bidirectional mode of functioning.
Step-up operation:	Designates the power flow from the variable voltage side to the DC link side. The sign of the current (vs_isoll) is positive.
Step-down operation:	Designates the power flow from the DC link side to the variable voltage side. The sign of the current (vs_isoll) is negative.

3.2 Technical Information and Data

Performance data:

Maximum power	3.5 kW
Ranges of voltage and current of the variable voltage side	
PM3K350	0...350V DC -10...0...10A
DC link voltage:	365-385 V
Own requirements:	stand by: approx. 5 W
Interfaces:	RS232 (CMOS level), galvanically isolated
Cooling	air cooling (temperature-guided fan)
Power supply:	by means of the DC link side (> 100V DC)
	by means of the component side (> 100V DC)
Interconnection of outputs:	can be connected in parallel
Galvanic isolation:	none

Environmental conditions:

Ambient temperature range	-20...50°C (during the operation)
Degree of protection	IP 00
Max. air humidity	up to 90% (not condensing)
Contaminants	The environment must not contain larger quantities of dust, in particular no metal or graphite dust.

Housing

Design	open frame
Dimensions	230 mm x 80 mm x 100 mm
Own weight	approx. 1.3 kg

Scope of Supply

- DC/DC converter module PM3K350 (preparameterized according to the type of module)
- Data carrier (CD)
- Parameter sets for current applications (on CD)
- Software for the visualization and parameterization (on CD)
- User's manual (on CD)

Optional

- Device system for max. 4 modules (variants on request)
- Preparameterization according to the planned utilization
- Initial commissioning on the customer's premises

3.3 Power Terminals

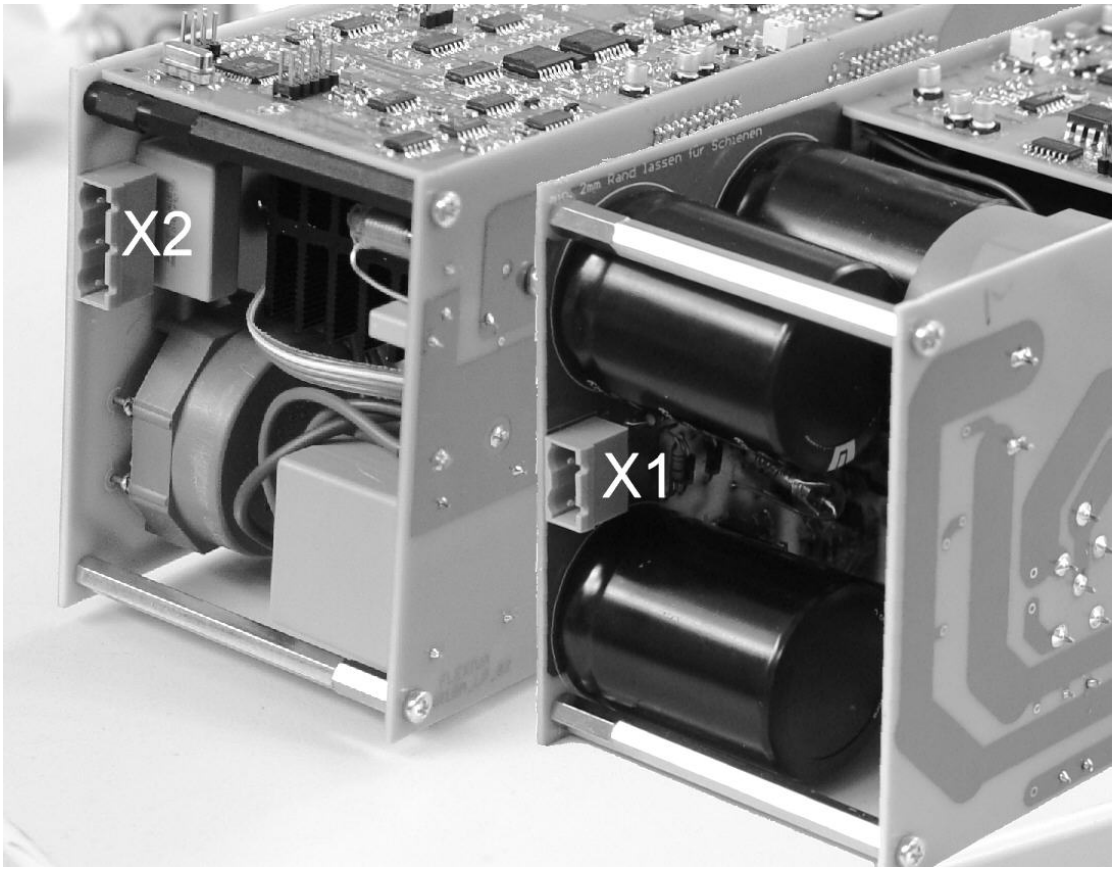

Fig. 2: Power terminals

X1: DC link

- Plug with clamp max. 2.5mm²

X2: Output

- Plug with clamp max. 2.5mm²
- +pole, -pole, PE

3.4 Signal Connections

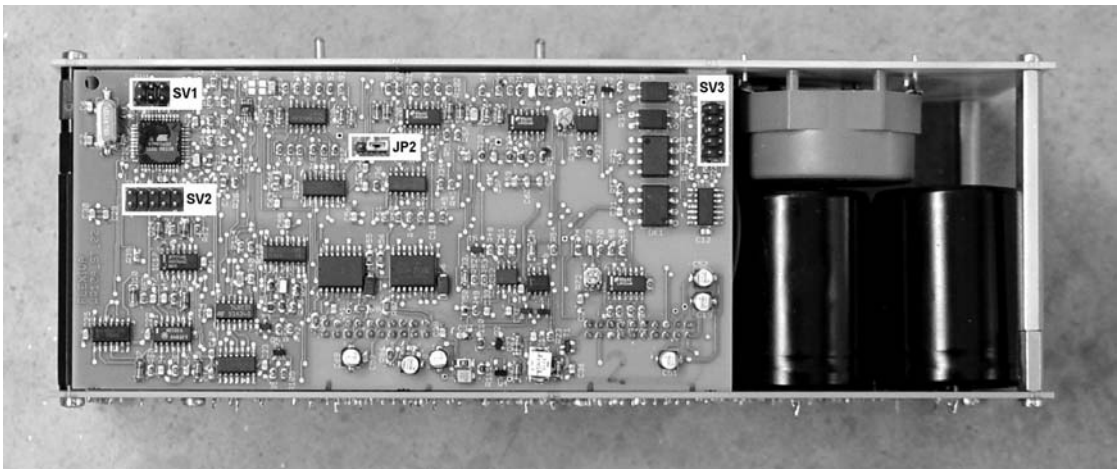

Fig. 3: Signal connections

SV3: Communication interface

The communication with the module is executed by means of an optically isolated serial interface: To trigger the optocouplers, a supply voltage of 5V (approx. 30mA) is to be provided. To permit to address several modules in a simple way, the signal RXD and TXD can be switched-in by means of the SELECT signal. When SELECT is low, TXD becomes a high-resistance value and RXD does not receive any signals. When several modules are used, the RXD and TXD lines can be connected in parallel this way and the currently addressed module can be selected by means of SELECT. All signals at this interface are on 5V CMOS level that means for the connection with a PC, a level converter is required such as, for example, represented in the appendix.

Data rate: 115,200bps,

Format: 8bit+1 stop bit

The signals OC_OK and OC_EN are provided for an additional safety feature: OC_OK gets low, when the DC link voltage has exceeded the upper limit value. Consequently, a module can inform all the others when this case has occurred by AND-combining all OC - OK signals and supplying them to OC - EN. This way, it is possible to prevent major damages when the voltage-measuring amplifier of the DC link of a module breaks down.

pin	abbreviation	explanation
1	GND	ground
2	VCC	+5 V
3	OC_OK	H: no overvoltage of the DC link
4	NC	not used
5	NC	not used
6	SELECT	H: serial interface activated L: serial interface deactivated
7	OC_EN	H: module enabled
8	RXD	input of data
9	NC	not used
10	TXD	output of data

Tab. 1: Pin assignment SV3

SV1 / SV2: Service interfaces

SV1 and SV2 are programming controllers for the microcontrollers of the module. They are not needed for the operation and are not to be used.

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3.5 Safety Information

The DC/DC converter module was developed according to recognized rules of technology and submitted to a safety test before the delivery.

In case of wrong operations or unauthorized use, there are still dangers for persons and the DC/DC converter modules.

All persons who erect, operate, or maintain the system must:

1. read and exactly follow the present operating manual,
2. be trained and instructed for their job.

Test voltage between DC link side and communication interface 6kVp

3.5.1 Safety Measures for the Installation

In order to guarantee a troublefree operation and to maintain the service life of the electronic components, any accumulation of heat, especially at the fronts of the module is to be avoided. The place of installation is to be selected so that the module is sufficiently ventilated during the operation.

Attention

The heat sinks are connected with potentials i.e. it is prohibited to touch them!

3.5.2 Remaining Dangers and Risks

The described product is in keeping with the latest technological development and meets the recognized safety provisions. Nevertheless, dangers and risks may arise.

The remaining dangers and risks occurring in connection with the operation of the system result from:

- the utilization of electric / electronic components (sources, acceptors, memories) of third-party suppliers,
- the electricity itself.

For all components built-in, the provisions and safety instructions with regard to the operation and the place of erection and/or installation applying to each of them are to be observed and complied with.

3.5.3 Qualification of the Operating Staff

Only such persons are authorized to commission and connect the module who have an electro-technical special training and who are able to execute the required line connections expertly.

Basic knowledge of the work on PCs and with the current WINDOWS operating system is required to use the software supplied along with the modules. Details about this are contained in the enclosed extensive program description.

4 Preparation of the Product for the Use

4.1 Transport

For the transport of the module, attention has to be to the fact that it is not exposed to any vibrations, heavy shocks as well as jolts and impacts since sensitive components might be damaged by that.

4.2 Packaging

Basically, packaging is to be used for the transport and/or shipment of the module that meets the requirements of the destination and the system and is environmentally acceptable.

Since the module itself has a degree of protection IP00, a transport packing is to be selected that prevents the penetrating of water, dirt, and dust. The inserting of conventional desiccating means in the packaging is recommended.

4.3 Storing

Durable storing: closed rooms, dry, room temperature

4.4 Commissioning

Prior to the commissioning, the following conditions are to be assured and to be checked:

- The expert installation and rating of all necessary electrical connection lines as well as the correct connection of all components to the module.
- The knowledge of the information and instructions given in the present user's manual.

4.4.1 Connection of the DC Link

- The cross section of the wires has to be selected according to the current expected → 1.5mm² are recommended.
- Take into account the polarity.

4.4.2 Connection of the Output

- The cross section of the wires has to be selected according to the current expected → 1.5mm² are recommended.
- Take into account the polarity.

4.4.3 Putting into Operation of the Module

1. Read the present documentation!
2. Apply the DC link voltage.
   From a voltage of approx. 100V onwards, it is possible to communicate with the module via RS232.
3. Parameterize it.
4. Switch it on.

5 Operation

5.1 Method of Functioning

The DC/DC converter module can transfer power between a DC link with a voltage of 365V...385V and a side with variable voltage in a bidirectional way. Since several degrees of freedom result from that a more extensive parameterization is required for that purpose. To reach a maximum flexibility in doing this, the control for the DC link voltage and the output voltage is digitally realized.

A PIDT1 controller each exists for the DC link and the output. Depending on the mode of operation, these are linked in a different way. The output value of this linkage is limited to the corresponding maximum values and is output to the hardware by means of DAC (vs_isoll). In addition to that, the I-Components of the controllers are also limited during the limitation so that they do not run up to the maximum values. They are kept at the limiting value so that are contiguous change from one to the other controller can be executed.

5.1.1 Modes of Operation

In order to link the output values of the output and DC link voltage regulator, two possibilities are available.

In the mode of operation 0, the maximum value of the two regulators is used. It is suited for the operation as an output converter i.e. only load flows out of the module into a load or for the application of a buffer store, for example of a double-film capacitor or accumulator. The linkage of the regulators works as follows: If the DC link voltage is bigger than its set desired value, the output voltage regulator is active and keeps U_{VS} at a constant level. If the voltage at the DC link drops, the DC link voltage regulator gains the upper hand and tries to keep the DC link voltage at a constant level. The following characteristics result from that for this mode of operation:

- the output voltage is limited upwards and this prevents, for example, an overcharging of the buffer store,
- the DC link voltage is limited downwards and this prevents a collapse of the DC link in case of a too big load.

Voltages	Tendencies	Input (1)	Output (0)
$U_{ZK}<U_{ZKsoll}$ $U_{VS}<U_{VSsoll}$	IsollZ ↑ IsollV ↓	Isoll ↓	Isoll ↑ (discharging of the buffer store)
$U_{ZK}>U_{ZKsoll}$ $U_{VS}<U_{VSsoll}$	IsollZ ↓ IsollV ↓	Isoll ↓	Isoll ↓ (charging of the output /buffer store)
$U_{ZK}<U_{ZKsoll}$ $U_{VS}>U_{VSsoll}$	IsollZ ↑ IsollV ↑	Isoll ↑ (input e.g. BZ)	Isoll ↑ (energy recovery)
$U_{ZK}>U_{ZKsoll}$ $U_{VS}>U_{VSsoll}$	IsollZ ↓ IsollV ↑	Isoll ↓	Isoll ↑ (energy recovery)

Tab. 2: Behavior in the modes of operation

In the mode of operation 1, the minimum value of the two regulators is used as a current default value. This is favorable for the linking of sources, e.g. of a fuel cell. In this mode of operation, it is prevented that the output voltage falls below the desired value and can thus, for example, damage a fuel-cell stack. Consequently, the voltage regulator of the DC link is usually in operation and keeps the DC link voltage at a constant level. Only when the output voltage falls below the desired value, the output voltage regulator gets active and reduces the current so that it is not possible to fall below the desired value.

Parameter: mod_opmode													
Bit								Dec	Hex		Mode of operation	Imax	Imin	UsollVS
7	6	5	4	3	2	1	0							
0	0	0	0	0	0	0	0	0	(0x10)	0x00	Output/buffer store	comm	comm	comm
0	0	0	0	0	0	0	1	1	(0x11)	0x01	Input	comm	comm	comm

Tab. 3: Modes of operation

5.1.2 Parallel Connection of Modules at the Variable Voltage Side

To increase the power, it is to be possible to interconnect several DC/DC converter modules at the variable voltage side. But this has the following disadvantage: Since PI controllers are used the output voltage is exactly regulated to meet the desired value. In case of two DC/DC converters connected in parallel, there are, however, always little differences in the voltage references so that one DC/DC converter always accepts the full load until it reaches its current limit. This is unfavorable since the efficiency of the DC/DC converter is just the highest one in the medium power range. This problem can be solved by a falling current-voltage characteristic. On principle, this one already exists through the resistances of the connecting leads, but too low.

The falling characteristic can be obtained in a simple way by a P-controller for the output voltage. But this is unfavorable here owing to the digital control because strong quantizing jumps in the desired value of the current occur owing to the high necessary amplifications. For that reason, the following arrangement is more favorable:
A PI-controller is applied as controller. But the multiple of the desired value of the current is added to the desired value of the voltage that was smoothed before by means of a PT1element with a relatively long time constant. This structure shows then a similar behavior like a voltage source being subject to an internal resistance that is jumpered by a big capacitor. This functionality is provided by the parameters vs_fkkp and vs_fkkt.

5.1.3 Virtual Capacitor

By means of the parameter set for the virtual capacitor functionality, the module can be parameterized so that the output voltage can be imaged on the desired value of the DC link voltage. If you connect, for example, a double-film capacitor to the output of a module the voltage of this capacitor changes along with its charging condition, too. This voltage is collected by the module, can be equipped with an offset (zk_vcko), is then amplified (zk_vckp), and possible filtered (zk_vckt) (Fig. 4).

5.1.4 Safety Shutdown

Apart from the already mentioned interconnected monitoring of the DC link voltage, the DC/DC converter module is also equipped with further safety shutdowns realized by the hardware.
Altogether, the following are available:

- Shutdown in case of excess temperature
- Shutdown in case of undervoltage at the variable voltage side
- Shutdown in case of overvoltage at the variable voltage side
- Shutdown in case of overcurrent at the variable voltage side
- Shutdown in case of overvoltage at the DC link

For the excess temperature shutdown, the temperature of the heat sink element is monitored. At a temperature of more than 93 °C at the heat sink element, the shutdown is carried out.

The output voltage is monitored so that any exceeding of and/or falling below a limit value is detected. The undervoltage shutdown is to serve for the fact that batteries or

fuel cells are protected in case of a breakdown of the control. The shutdown is activated at an exceeding of and/or falling below the limit value amounting to approx. 3% of the total range.

The overcurrent shutdown is to respond in case of a breakdown of the control, too.

All errors are filed in the variable mod_state and have to be acknowledged and consequently reset by putting err_quit on 1.

parameter: mod_state												
Bit								Dec	Hex	status	Reaction of the system	Restart when error eliminated
7	6	5	4	3	2	1	0					
0	0	0	0	0	0	0	0	0	0x00	no error	shutdown, err_quit=0	err_quit=1
0	0	0	0	0	0	0	1	1	0x01			
0	0	0	0	0	0	1	0	2	0x02	U_ZK too low	shutdown, err_quit=0	err_quit=1
0	0	0	0	0	1	0	0	4	0x04	hardware error	shutdown, err_quit=0	err_quit=1
0	0	0	0	1	0	0	0	8	0x08			
0	0	0	1	0	0	0	0	16	0x10	excess temperature	shutdown, err_quit=0	err_quit=1
0	0	1	0	0	0	0	0	32	0x20	I_VS too high	shutdown, err_quit=0	err_quit=1
0	1	0	0	0	0	0	0	64	0x40	U_VS too low/high	shutdown, err_quit=0	err_quit=1
1	0	0	0	1	0	0	0	128	0x80	U_ZK too high	shutdown, err_quit=0	err_quit=1

Tab. 4: Error codes

5.1.5 Other Errors

Furthermore, errors generated by the software are registered in the variable mod_state, too. These are the errors 0x02 and 0x04. The error-ID 0x04 occurs when the power supply of the module is not guaranteed or the connected overvoltage shutdown of the DC link has responded.

The error 0x02 is generated when the DC link voltage collapses during the operation.

5.1.6 Empty DC Link

When the DC link voltage is smaller than 100V, the module is out of action since it is completely supplied with the help of the DC link side (the DC link itself). Only at a voltage exceeding 100V, the communication with the module is possible.

It is also possible to supply the module with the help of the component side (e.g. if a source or buffer is connected there). If the voltage is higher than 100V, it is possible to communicate with the module and carry out the switching-on.

5.2 Basic Parameterization

The module can only be parameterized by means of the serial interface. It is, however, more convenient to do this by means of the software belonging to it.

R	read
W	write (parameterizable)
E	stored in the EEPROM
B	can be changed in switched-on state (mod_on=1)

5.2.1 Currents of Variable Voltage Side

Type of module	Range of values	Communication values	Resolution
350V	-10A..10A	-1000..1000	10mA

parameter	**vs_imin**	
description	lower desired value(stepping-down)	
explanation		
instruction	WJ	**RW B**

parameter	**vs_imax**	
description	upper desired value(stepping-up)	
explanation		
instruction	WI	**RW B**

parameter	**vs_imin_f**	
description	lower desired value, initial value in the EEPROM	
explanation	This value accepts vs_imin directly after the putting into operation of the module by the applying of the operating voltage.	
instruction	WL	**RW E**

parameter	**vs_imax_f**	
description	This value accepts vs_imax directly after the putting into operation of the module by the applying of the operating voltage.	
explanation		
instruction	WK	**RW E**

parameter	**vs_imin_g**	
description	lower limit	
explanation	not used	
instruction	WN	**RW E**

parameter	**vs_imax_g**	
description	upper limit	
explanation	not used	
instruction	WM	**RW E**

parameter	**vs_iminmax**	
description	shutdown value	
explanation		
instruction	WG	**RW E**

parameter	**vs_isoll**	
description	actual value I_{VS}	
explanation	Output value of the controller that is transferred to the hardware as desired value of the current and normally turns up.	
instruction	WA	**R**

5.2.2 Voltages of Variable Voltage Side

Type of module	**Range of values**	**Communication values**	**Resolution**
350V	0..350 V	0.. 3500	406 mV

parameter	**vs_umax_g**	
description	upper limit U_{VS}	
explanation	for automatic mode	
instruction	VM	**RW E**

parameter	**vs_umin_g**	
description	lower limit U_{VS}	
explanation	for automatic mode	
instruction	VN	**RW E**

parameter	**vs_umaxmax**	
description	upper switching-off value	
explanation		
instruction	VO	**RW E**

parameter	**vs_uminmin**	
description	lower switching-off value	
explanation		
instruction	VP	**RW E**

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parameter	**vs_usoll_f**	
description	desired value U_{VS}, initial value in the EEPROM	
explanation	This value accepts vs_usoll directly after the putting into operation of the module by the applying of the operating voltage.	
instruction	VV	**RW E**

parameter	**vs_usoll**	
description	desired value U_{VS}	
explanation		
instruction	VU	**RW B**

parameter	**vs_uist**	
description	actual value U_{VS}	
explanation	Actual value voltage variable voltage side, is only displayed when the module is switched-on (relay picked up).	
instruction	VA	**R**

5.2.3 Voltages of the DC Link Side

Type of module	**Range of values**	**Communication values**	**Resolution**
all types	350..400V	3500..4000	100 mV (internally 50 mV)

Attention

The DC link voltage is only measured in the range of 350V to 400V. If it is smaller than 350V, the value 3500 is output. Before work is done at the DC link cabling the DC link voltage has to be measured and the DC link must be discharged.

parameter	**zk_umax_g**	
description	upper limit	
explanation	not used	
instruction	ZM	**RW E**

parameter	**zk_umin_g**	
description	lower limit	
explanation	not used	
instruction	ZN	**RW E**

parameter	**zk_usoll**	
description	desired value DC link voltage U_{ZK}	
explanation		
instruction	ZU	**RW B**

parameter	**zk_usoll_f**	
description	desired value DC link voltage U_{ZK}, initial value in the EEPROM	
explanation	This value accepts zk_usoll directly after the putting into operation of the module by the applying of the operating voltage.	
instruction	ZV	**RW E**

parameter	**zk_uist**	
description	actual value DC link voltage U_{ZK}	
explanation		
instruction	ZA	**R**

5.2.4 Information

parameter	**mod_state**	
description	module status	
explanation	error codes see Tab. 4	
instruction	IS	**R**

parameter	**mod_opmode**	
description	module mode of operation	
explanation	see Tab. 3	
instruction	IM	**RW E**

parameter	**-**	
description	module type No.	
explanation	module type (350 V)	
instruction	IT	**R**

parameter	**-**	
description	module firmware	
explanation	software state of the firmware	
instruction	IF	**R**

parameter	**-**	
description	module serial No.	
explanation	serial number of the manufacturer	
instruction	IN	**R**

parameter	**-**	
description	module man. date	
explanation	manufacturing date	
instruction	ID	**R**

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parameter	**t_kk**	
description	temperature heat sink element	
explanation	communication value 0..1000 corresponds to -273..127°C	
instruction	TK	**R**

parameter	**t_trafo**	
description	temperature transformer	
explanation	not used	
instruction	TT	**R**

5.2.5 Commands

parameter	**mod_on**	
description	module on / off	
explanation	1: on 0: off	
instruction	CE	**RW B**

parameter	**err_quit**	
description	acknowledging of the error	
explanation	1: acknowledging of the error	
instruction	CQ	**RW B**

parameter	**com_mode**	
description	reading-out of the communication mode	
explanation	0: ASCII short 1: ASCII long	
instruction	CC	**R B**

5.2.6 Oscilloscope

For the setting of the regulator parameters and for the observing in the operation, an oscilloscope functionality is integrated into the software. By means of it, output voltage, DC link voltage and output current can be recorded. 256 values with a resolution of 8bit are recorded. The possible scanning frequency is in the range from 6kHz and 23,4Hz.

The channel where triggering is done can be selected independently of the recorded channel.

In order to image the 10-bit and/or 11-bit values of voltages and currents onto the 8-bit recording range, there are various possibilities available. It is either possible to scale the complete range of values to 0...256 with the 0 being at 128 in case of I_VS. Or it is also possible to image only the amount of the positive or negative range of values from 0 to 256. Or it is possible to choose the full resolution (currents: -1,000...1,000, voltages 0...1.000) and to shift it by means of an offset in the range 0...256 of the recording.

	scaled range	real range 350V module
I_VS	-1000 0 +1000	-10A 0A +10A
U_VS	1000 0	350V 0
U_ZK	1000 0	400V 350V

parameter	**osz_ch**	
description	channel	
explanation	0: U_VS 1: U_ZK 2: I_VS	
instruction	OK	**RW B**

parameter	**osz_ft**	
description	frequency divider	
explanation	pulse frequency: 6kHz/osz_ft 0 corresponds to 6kHz/256	
instruction	OF	**RW B**

parameter	**osz_tr**	
description	trigger value	
explanation	trigger value for all channels between -1,000 and 1,000	
instruction	OT	**RW B**

parameter	**osz_tch**	
description	trigger channel	
explanation	0: U_ZK 1: U_A 2: I_A	
instruction	OC	**RW B**

parameter	**osz_m**	
description	storage mode	
explanation	see Tab. 5	
instruction	OM	**RW B**

parameter: osz_m										
Bit								Dec	Hex	meaning
7	6	5	4	3	2	1	0			
x	x	x	x	x	x	x	0	0	0x00	triggering at value > trigger value
x	x	x	x	x	x	x	1	1	0x01	triggering at value < trigger value
x	x	x	x	x	0	0	x	0	0x00	complete range of values to 0…255
x	x	x	x	x	0	1	x	2	0x02	value(10-bit)-offset cut-off on 0..255
x	x	x	x	x	1	0	x	4	0x04	positive range of values to 0..255
x	x	x	x	x	1	1	x	6	0x06	negative range of values inverted to 0..255
x	x	x	0	0	x	x	x	0	0x00	trigger position 0 %
x	x	x	0	1	x	x	x	8	0x08	trigger position 25%
x	x	x	1	0	x	x	x	16	0x10	trigger position 50%
x	x	x	1	1	x	x	x	24	0x18	trigger position 75%

Tab. 5: Modes of operation of oscilloscope

parameter	**osz_offs**	
description	offset	
explanation	for storage mode with offset	
instruction	OO	**RW B**

parameter	**osz_on**	
description	osci on / off	
explanation	osci starting / status	
instruction	OE	**RW B**

parameter	**-**	
description	osci reading-out	
explanation	reading-out of the 256 values (ASCII)	
instruction	OR	**R**

parameter: osz_on										
Bit								Dec	Hex	meaning
7	6	5	4	3	2	1	0			
x	x	x	x	x	x	x	0	0	0x00	does not run
x	x	x	x	x	x	x	1	1	0x01	runs, waits for trigger
x	x	x	x	x	x	1	x	2	0x02	runs, triggered

Tab. 6: Status values of oscilloscope

5.3 Regulator Setting

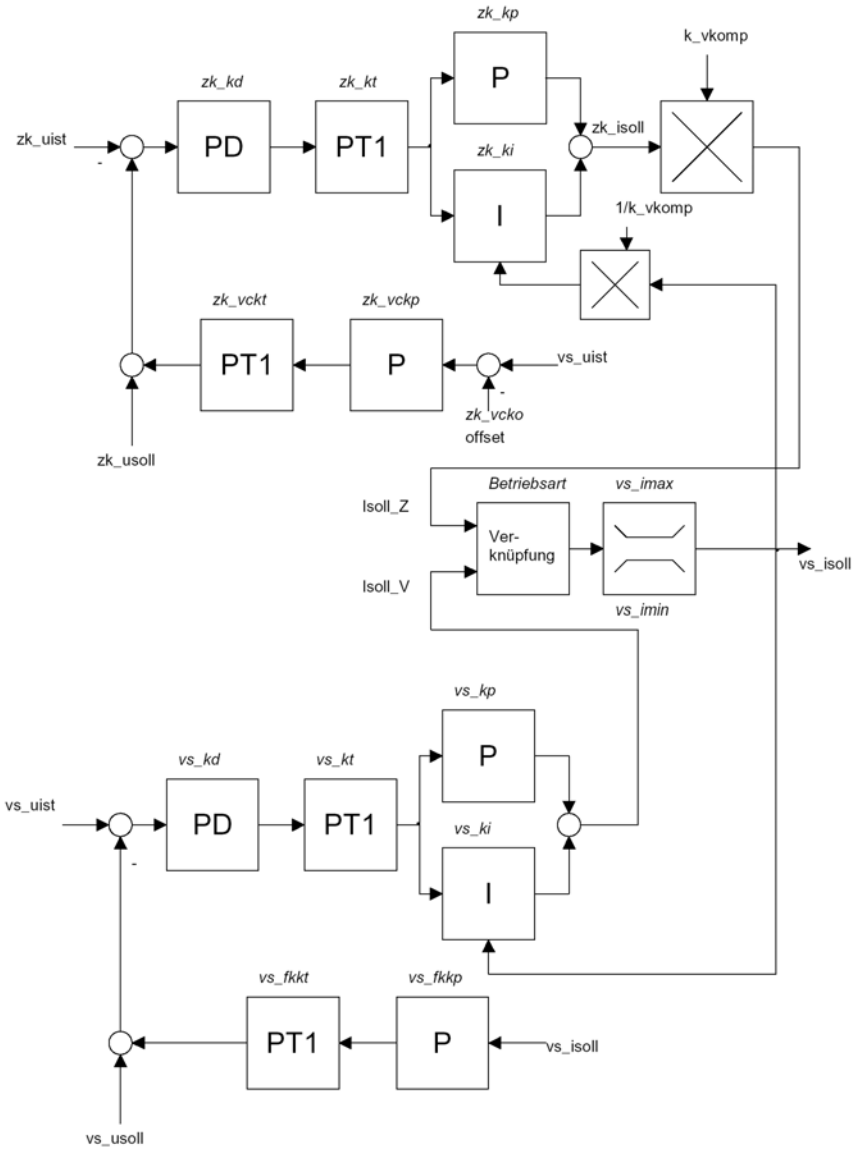

Fig. 4: Block diagram of the voltage controls

5.3.1 Regulator Parameters of the Variable Voltage Regulator

Basic amplifications (not represented in the block diagram):

350V module: 0.0123 A/V

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parameter	**vs_ki**	
description	I component	
explanation	range of parameters: 0..255 transfer function: $G=V_I/p$ V_I: 0..12000s^{-1} $V_I=12000s^{-1}/256*vs\_ki$	
instruction	UI	**RW E**

parameter	**vs_kp**	
description	P component	
explanation	range of parameters: 0..255 amplification: 0..255	
instruction	UP	**RW E**

parameter	**vs_kd**	
description	D component PD-element	
explanation	range of parameters: 0..255 transfer function: $G=V_D*p+1$ V_D: 0..1,67ms $V_D=vs\_kd*1/6000Hz$	
instruction	UD	**RW E**

parameter	**vs_kt**	
description	filter time constant PT1-element	
explanation	range of parameters: 0..255 transfer function: G=1/(1+pT) T: 43ms..0,17ms T=256/(vs_kt*6000Hz)	
instruction	UT	**RW E**

parameter	**vs_fkkp**	
description	amplification falling characteristic	
explanation	range of parameters: 0..255 350V-Modul: v=(41V/A)/256*vs_fkkp	
instruction	UK	**RW E**

parameter	**vs_fkkt**	
description	filter time constant falling characteristic	
explanation	range of parameters: 0..255 transfer function: G=1/(1+pT) T: 43ms..0,17ms T=256/(vs_fkkt*6000Hz)	
instruction	UZ	**RW E**

5.3.2 Regulator Parameters of the DC Link Regulator

Basic amplification (not included in the block diagram): 0.054A/V

parameter	**zk_ki**	
description	I component	
explanation	range of parameters: 0..255 transfer function: $G=V_I/p$ V_I: 0..12000s^{-1} V_I=12000s^{-1}/256*zk_ki	
instruction	YI	**RW E**

parameter	**zk_kp**	
description	P component	
explanation	range of parameters: 0..255 amplification: 0..255	
instruction	YP	**RW E**

parameter	**zk_kd**	
description	D component	
explanation	range of parameters: 0..255 transfer function: $G=V_D*p+1$ V_D: 0..3,33ms V_D=zk_kd*1/3000Hz	
instruction	YD	**RW E**

parameter	**zk_kt**	
description	filter time constant	
explanation	range of parameters: 0..255 transfer function: G=1(1+pT) T: 85ms..0,33ms T=256/(zk_kt*3000Hz)	
instruction	YT	**RW E**

parameter	**zk_vckp**	
description	amplification of virtual capacitor	
explanation	range of parameters: 0..255 350V module: v=0,123/256*zk_vckp	
instruction	YK	**RW E**

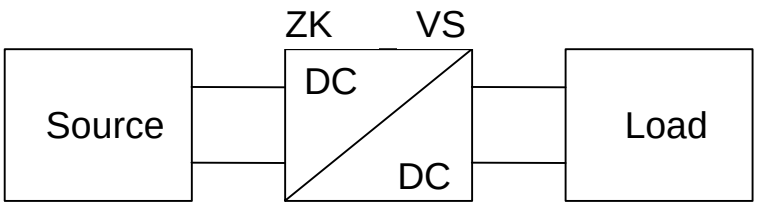
parameter	**zk_vckt**	
description	filter time constant of virtual capacitor	
explanation	range of parameters: 0..255 transfer function: G=1(1+pT) T: 85ms..0,33ms T=256/(zk_vckt*3000Hz)	
instruction	YZ	**RW E**

parameter	**zk_vcko**	
description	offset of virtual capacitor	
explanation	corresponds to voltage at variable voltage side 350V module: 0..3,500	
instruction	YO	**RW E**

5.4 Typical Cases of Application / Parameterization Examples

To be able to operate the DC/DC converter module in a certain arrangement, some parameters have to be placed correctly. In the following example configurations, useful instructions are given for the correct parameterization.

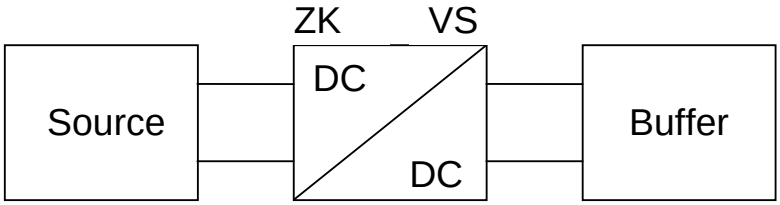
Apart from the basic parameters mod_opmode, vs_imax, vs_imin, vs_usoll, zk_usoll, it is also recommended to modify the regulator parameters and to use only a P-regulator instead of a PI-regulator under certain conditions.

a)		
Application	possible sources: DC network, PFC possible load: any load you like	
Parameter	mod_opmode:	0
	vs_imax:	0 respectively >0
	vs_imin:	- desired current limit
	zk_usoll:	desired value DC link voltage, smaller than minimally occurring DC link voltage
	vs_usoll:	desired output voltage

In this case of application, the module works like a typical power supply: it keeps the output voltage on the desired value vs_usoll at a constant level and limits the current in case of overload to vs_imin. (Attention: vs_imin is negative since the current direction is defined inside the module.) The parameter vs_imax should be on 0 so

that no current can flow into the module. In some cases, this can, owing to offset errors, lead to the fact that the voltage ramps-up when no load is connected. In this case, it is recommended to give vs_imax a small positive value of approx. 1..3A to ensure that the voltage can be kept at the desired value.

The parameter zk_usoll is the desired value for the DC link voltage. If it falls below the value, the voltage regulator of the DC link tries to maintain the same by preventing that power flows from the DC link to the variable voltage side. This means that the output voltage collapses in case of overload. If this is not desired and a hard shutdown is to be carried through in case of overload instead of that, zk_usoll is to be put onto the minimally possible value 3,500 (corresponds to 350V). If the DC link voltage collapses now the regulator cannot intervene and the module switches off because of a too low DC link voltage.

b)		
Application	buffering of a DC link e.g. by means of an accu or supercap	
Parameter	mod_opmode:	0
	vs_imax:	+ desired current limit
	vs_imin:	- desired current limit
	zk_usoll:	desired value DC link voltage
	vs_usoll:	max. back-up voltage

This arrangement serves to buffer a DC link. The maximum current flowing into the module, i.e. the buffer-discharging current is fixed by means of vs_imax, the maximum current flowing out of the module, the buffer-charging current, is fixed by vs_imin. The parameter vs_usoll serves to limit the back-up voltage upwards. If you also want to limit the buffer-discharging voltage downwards, you can realize this with the help of the parameter vs_uminmin – but here, a deviation of 1/120 of the voltage range of the variable voltage is to be taken into account.

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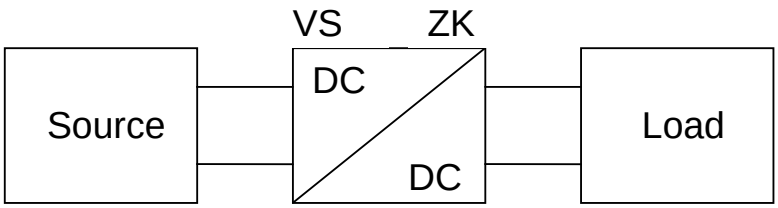
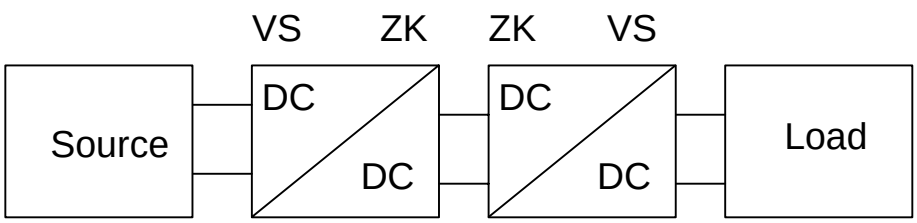
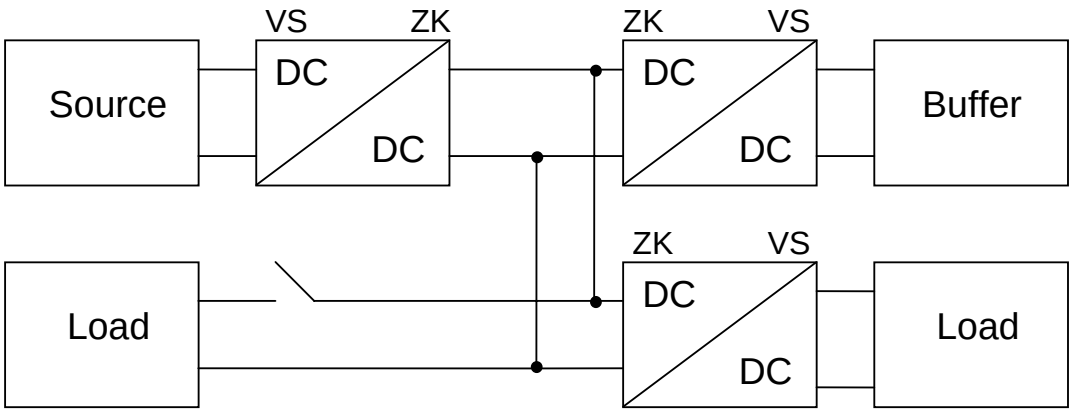
Now the voltage regulator of the DC link keeps the voltage on the desired value zk_usoll at a constant level. If the DC link voltage exceeds the desired value, the buffer store is charged, if it falls below the desired level, it is discharged. You can reach a softer behavior that offers itself, for example, in case of pulsating DC link voltages if you parameterize the voltage regulator of the DC link as a P-regulator.

c)	
Application	possible sources: fuel cell, accu possible loads: chopper-type power supply unit, motor power converter, inverter
Parameter	mod_opmode: 1 vs_imax: + desired current limit vs_imin: 0 zk_usoll: desired value DC link voltage vs_usoll: smaller than minimum input voltage

Another imaginable case of application is the generation of a high DC link voltage from a source with a low voltage. By the selection of mod_opmode=1, it is reached that the voltage regulator of the DC link is active for vs_uist > vs_usoll and regulates the DC link voltage to the desired value. The regulator of the variable voltage only intervenes when the value is less than the value vs_usoll on the variable voltage side and prevents an undervoltage at the source. If the load remains unchanged in this case, the DC link voltage drops and results in the shutdown.

d)		
Application	any application you like, disadvantage: low efficiency	
Parameter module to source	mod_opmode: vs_imax: vs_imin: zk_usoll: vs_usoll:	1 + desired current limit 0 desired value DC link voltage smaller than minimum input voltage
Parameter module to load	mod_opmode: vs_imax: vs_imin: zk_usoll: vs_usoll:	0 0 respectively >0 - desired current limit desired value DC link voltage, smaller than minimally occurring DC link voltage desired output voltage

This case is the interconnection of configuration a) and configuration c). During the switching-on, you have to comply with the following sequence of operations: switch-on the module at the source, wait until the DC link is loaded, switch-on the module at the load.

e)	
application	full system comprising source, load, and buffer store
Parameter module to source	mod_opmode: 1 vs_imax: + desired current limit vs_imin: 0 zk_usoll: desired value DC link voltage vs_usoll: smaller than minimum input voltage
Parameter module to buffer	mod_opmode: 0 vs_imax: + desired current limit vs_imin: - desired current limit zk_usoll: desired value DC link voltage vs_usoll: max. back-up voltage
Parameter module to load	mod_opmode: 0 vs_imax: 0 respectively >0 vs_imin: - desired current limit zk_usoll: desired value DC link voltage, smaller than minimally occurring DC link voltage vs_usoll: desired output voltage

On principle, this case is an interconnection of the arrangements a) to c). But there are several possibilities of the power distribution.

In the simplest case, you parameterize zk_usoll_{Last}<zk_usoll_{Puffer}<zk_usoll_{Quelle}. If the load is bigger than the source is able to supply (variable voltage is limited downwards), the DC link voltage collapses and the converter at the buffer store keeps it at its desired value. When the load gets smaller again, the converter at the source remains in the mode voltage control of the variable voltage while the buffer store is able to refills. As soon as the buffer store is full, the variable voltage regulator takes effect at the buffer store and limits the back-up voltage upwards. To limit the current rise at the source in this mode of operation, e.g. to protect a fuel cell, the delay of the voltage regulator of the DC link is to be increased, i.e. a smaller value of zk_kt has to be selected.

Another possibility is the utilization of the mode of operation “Virtual capacitor”. Because of that, a continuous waveshape of the DC link voltage is reached proportionally to the fill level of the buffer store. The DC/DC converter at the load draws again the power from the DC link. The buffer store converter keeps the DC link voltage at a constant level by means of a PI-regulator. But now the desired value for the DC link voltage is changed depending on the charging condition of the buffer store. The less the buffer store is charged the lower the DC link voltage gets. The DC/DC converter module at the source has got now a P-regulator with delay to smooth the desired value. If the DC link voltage now gets lower, this DC/DC converter supplies more power. If the load gets less now, more power flows into the buffer store, this leads to a rise of the DC link voltage and the power drawn from the fuel cell decreases.

The third possibility is the control of the power flow by means of a higher-level control (internally or externally). In such a system, the buffer store keeps the DC link voltage at a constant level, the higher-level control monitors the charging condition of the buffer store and triggers the source on this basis. This way, the combination of several sources and buffers (e.g. long-term and short-term storage devices) is possible.

5.5 Error Treatment

Acknowledging of the error, eliminating of the cause, restarting.

6 Programming / Parameterization

6.1 Preliminary Remarks

The DC/DC module offers a convenient software interface. All parameters / commands / measured values can be written and/or read by means of a simple ASCII protocol. All module variables no matter whether they represent a parameter, a measured value or a command are addressable by means of an instruction code consisting of two characters. The first character indicates the respective group membership, e.g. "z" for the voltage parameters of the DC link and the second character then specifies the concrete variable. A complete list of all instruction codes is part of the present documentation.

The serial interface of the modules serves as (hardware) communication interface. It can, for example, be connected with the RS232 interface of a PC. The following settings are required:

bits per second	115200
data bits	8
parity	none
stop bits	1
flow control	none

Tab. 7: Settings RS232

6.2 The ASCII Protocol Used

The transfer of the corresponding commands in the ASCII format is done in a simple scheme. All characters transferred to the module are immediately evaluated by the same and checked with regard to their validity within the respective sequence of commands. This means concretely: If, for example, a plus/minus sign is expected at a certain point of a sequence of commands, the module only accepts the signs plus(+) or minus(-). Valid characters are directly mirrored (exceptions: control characters for the protocol changeover and CR), invalid characters are immediately rejected. Because of this proceeding, you save yourself large-scale taking down on record (test sums, length specifications, etc.) and you can nevertheless minimize incorrect entries.

6.2.1 Reading / Writing

Basically, you have to distinguish between "Reading" and "Writing" as far as the sequences of instructions to be sent to the module are concerned. If, for example, the value stored in a module variable is only to be read, you have to send the corresponding abbreviation as a sequence followed by Return, If a new value is to be stored in a variable, the corresponding abbreviation, the plus/minus sign of the new value, the new value itself and Return are to be sent.

read	**write**
instruction code + CR	instruction code + sign + new value + CR

Tab. 8: Instruction sequences in general

The following table lists all possible instruction codes for the communication with the module and they are arranged in groups. At the same time, the names of the respective module variables as well as the place of storing and the parameterizability are shown.

Group	Description	1. Command Character	2. Command Character	parame-trizable	stored in EEPROM	Parameter
DC Link	voltage: upper Limit (not used)	z	m	x	x	zk_umax_g
(DC link side)	voltage: lower Limit (not used)	z	n	x	x	zk_umin_g
	voltage: desired initial value	z	v	x	x	zk_usoll_f
	voltage: desired value	z	u	x+		zk_usoll
	voltage: actual value	z	a			zk_uist
	I-component of the DC-link regulator	y	i	x	x	zk_ki
	P-component of the DC-link regulator	y	p	x	x	zk_kp
	D-component of the DC-link regulator	y	d	x	x	zk_kd
	filter time constant of the DC-link regulator	y	t	x	x	zk_kt
	virtual capacitor: amplification	y	k	x	x	zk_vckp
	virtual capacitor: filter time constant	y	z	x	x	zk_vckt
	virtual capacitor: offset	y	o	x	x	zk_vcko
Variable Voltage	current: minimum	w	j	x+		vs_imin
(component side)	current: maximum	w	i	x+		vs_imax
	current: minimum, initial value	w	l	x	x	vs_imin_f
	current: maximum, initial value	w	k	x	x	vs_imax_f
	current: lower limit (not used)	w	n	x	x	vs_imin_g
	current: upper limit (not used)	w	m	x	x	vs_imax_g
	current: actual value	w	a			vs_isoll
	current: switch-off value	w	g	x	x (Elpoti)	vs_iminmax
	voltage: upper limit (for special use)	v	m	x	x	vs_umax_g
	voltage: lower limit (for special use)	v	n	x	x	vs_umin_g
	voltage: switch-off value, upper limit	v	o	x	x (Elpoti)	vs_umaxmax
	voltage: switch-off value, lower limit	v	p	x	x (Elpoti)	vs_uminmin
	voltage: desired initial value	v	v	x	x	vs_usoll_f
	voltage: desired value	v	u	x+		vs_usoll
	voltage: actual value	v	a			vs_uist
	I-component of the variable voltage regulator	u	i	x	x	vs_ki
	P-component of the variable voltage regulator	u	p	x	x	vs_kp
	D-component of the variable voltage regulator	u	d	x	x	vs_kd
	filter time constant of the variable volt. regul.	u	t	x	x	vs_kt
	falling characteristics: amplification	u	k	x	x	vs_fkkp
	falling characteristics: filter time constant	u	z	x	x	vs_fkkt
Temperatures	temperature heat sink	t	k			t_kk
	temperature transformer	t	t			t_trafo
Info	module state	i	s			mod_state
	module operating mode	i	m	x	x	mod_opmode
	module type	i	t			
	module firmware	i	f			
	module serial number	i	n		x	
	module date of manufacture	i	d		x	
Commands	module on / off	c	e	x+		mod_on
	error quit	c	q	x		err_quit
	communication mode	c	c			com_mode
Oscilloscope	channel	o	k	x+		osz_ch
	frequency divider	o	f	x+		osz_ft
	trigger value	o	t	x+		osz_tr
	trigger channel	o	c	x+		osz_tch
	storage mode	o	m	x+		osz_m
	offset	o	o	x+		osz_offs
	oscilloscope on / off	o	e	x+		osz_on
	oscilloscope readout	o	r			
x+ also parametrizable, if the module is switched on (mod_on=1)						

Tab. 9: Complete table of the instruction codes

6.2.2 ASCII-long / ASCII-short

On the part of the module answer, two protocol variants are possible: "long" and "short" ASCII protocol. ASCII-long is particularly suited for the manual entry of instructions, e.g. by using a terminal program such as "HyperTerminal“ from Windows. When this protocol is set, the module sends any information and (error) messages in clear text and sees to a distinct representation in the terminal program by means of the transfer of CR and NL control characters at corresponding points.

On the other hand, the protocol ASCII-short should be used when the instruction is to be handed over from another software such as, for example, from the software "ModulConfigSuite" of Flexiva. If this program is set, any information and (error) messages in clear text are suppressed. In case of an error, only error codes are transferred.

	ASCII-long	**ASCII-short**
without error	- instruction code + CR + NL - sign + read value + CR + NL - „OK“ + CR + NL + NL	- instruction code + CR - sign + read value + CR
with error	- instruction code + CR + NL - error code + CR + NL - error (information) text + CR + NL + NL	- instruction code + CR - error code + CR

Tab. 10: Module answer for the reading of a parameter / value

	ASCII-long	**ASCII-short**
without error	- instruction code + sign + new value + CR + NL - sign + value read back Wert + CR + NL - „OK“ + CR + NL + NL	- instruction code + sign + new value + CR - sign + value read back Wert + CR
with error	- instruction code + sign + new value + CR + NL - error code + CR + NL - error (information) text + CR + NL + NL	- instruction code + sign + new value + CR - error code + CR

Tab. 11: Module answer for the writing of a parameter / value

The changeover between the two variants is executed by putting a control character in front of the respective first sequence of commands. The control character can also be sent separately. The respective protocol setting is preserved until the next protocol changeover and/or to the next restart (supply voltage gone) or reset of the module. As a standard setting, ASCII-short is set.

Protocol variant	**Control character to the module**
ASCII-short	$
ASCII-long	%

Tab. 12: Protocol changeover

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6.2.3 Concrete Example

To explain the above-mentioned paragraphs, the sequences of instructions to be transferred to the module and the corresponding answers of the module are listed in the following at a concrete example. The case without errors is treated.

The module variable zk_umin_g is to be read-out and a new value is to be stored in it. The corresponding code is "zn", the old value in the variable is "+3500" and the new value is "+3600". This results for the two ASCII modes in the following communication with the module:

To the module																							
ASCII	%	z	n	CR																			
HEX	25	7A	6E	OD																			
From the module																							
ASCII		z	n	CR	NL	+	3	5	0	0	CR	NL	O	K	CR	NL	NL						
HEX		7A	6E	0D	0A	2B	33	35	30	30	0D	0A	4F	4B	0D	0A	0A						

Tab. 13: Reading ASCII-long

To the module																							
ASCII	$	z	n	CR																			
HEX	24	7A	6E	OD																			
From the module																							
ASCII		z	n	CR	+	3	5	0	0	CR													
HEX		7A	6E	0D	2B	33	35	30	30	0D													

Tab. 14: Reading ASCII-short

To the module																							
ASCII	%	z	n	+	3	6	0	0	CR														
HEX	25	7A	6E	2B	33	36	30	30	0D														
From the module																							
ASCII		z	n	+	3	6	0	0	CR	NL	+	3	6	0	0	CR	NL	O	K	CR	NL	NL	
HEX		7A	6E	2B	33	36	30	30	0D	0A	2B	33	36	30	30	0D	0A	4F	4B	0D	0A	0A	

Tab. 15: Writing ASCII-long

To the module																							
ASCII	$	z	n	+	3	6	0	0	CR														
HEX	24	7A	6E	2B	33	36	30	30	0D														
From the module																							
ASCII		z	n	+	3	6	0	0	CR	+	3	6	0	0	CR								
HEX		7A	6E	2B	33	36	30	30	0D	2B	33	36	30	30	0D								

Tab. 16: Writing ASCII-short

6.2.4 Error Messages

All sequences arriving in the module are immediately checked and processed. The following errors can occur during the reading / writing and these errors concern exclusively the parameterizing process and are not to be confused with the errors that may arise during the operation of the module and are coded in the status variable mod_state (Tab. 4):

Error code	Meaning in clear text
E0	Reserve
E1	Reserve
E2	Unknown module command
E3	Value beyond the range of values
E4	Value is only readable
E5	Device must be switched-off
E6	Elpotis could not be written. Jumper 1 must be closed.
E7	Mode of operation must be <16
E8	Min value must be smaller than max value

Tab. 17: Error messages

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6.3 Communication by Means of Terminal Software

Because of the utilization of an ASCII protocol for the communication interface, a communication with the module is possible by means if any terminal software you like. As an example, HyperTerminal is mentioned here that exists in Windows as a standard outfit (see Fig. 5). Of course, every other software can be also applied (Freeware, self-developed software) by means of which a bidirectional serial communication is possible. For the utilization of a terminal software, the protocol setting ASCII-long is recommended.

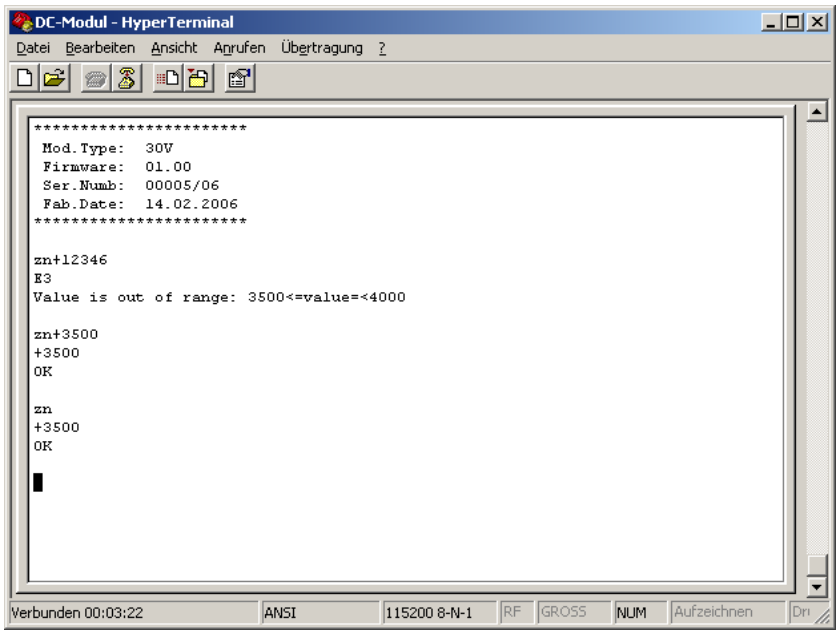

Fig. 5: Module parameterization by means of terminal software

6.4 Communication by Means of ModulConfigSuite

Another and much more convenient possibility is the utilization of the Windows software "ModulConfigSuite“ from the company Flexiva that is contained in the scope of delivery of the DC/DC module as a standard component. This software permits a convenient communication and a closed access (parameterizing / monitoring / storing) to all variables (parameters / commands / measured values) of every single module. Furthermore, it is possible to communicate simultaneously with up to 4 modules. The ModulConfigSuite uses the protocol setting ASCII-short.

7 The Parameterizing Software "ModuleConfigSuite"

7.1 Preliminary Remarks

A Windows software for the PC is supplied along with the module. It is intended for the convenient parameterization and visualization of all parameters / commands / measured values as well as for the recording of select data on the fixed disk. In the following, details concerning the function and operation of this software are explained.

System Prerequisites

Hardware:
- customary PC of medium performance and RS232 interface

Operating system:
- MS Windows (from Windows XP SP2 onwards)

7.2 Installation

The software is installed like any other conventional Windows software:

1. Insert the data carrier.
2. Start the installation by means of starting the file **setup.exe**.
3. Follow the instructions given by the installation program (path entry etc.).
    a. Installation step backwards by means of a click onto **Back**
    b. Installation step forwards by means of a click onto **Next**
    c. Stop the installation by means of a click onto **Cancel**.
4. Terminate the installation by means of a click onto **Finish**.

7.3 Deinstallation

If the software is to be removed from the fixed disk, you proceed as follows:

1. Open the **Start menu** of Windows.
2. Select **System control**.
3. In the system control panel click onto the symbol **Software**.
   A list of the available programs is displayed.
4. Select from the list the symbol for **ModulConfigSuite**.
1. Click onto **Remove**. The software is de-installed now.

7.4 Constructional Design of the Software

7.4.1 Overview

After the start of the software and the successful establishing of a connection to one or several modules (click onto "Connect!" in the menu line), the following window is displayed in which a division into three parts that is into a menu line, a button bar directly under the menu line and the remaining display area can be recognized. Only those modules are displayed with which a connection is to be established (see paragraph "Selection and Assignment of the Interfaces“) and a connection was successfully established.

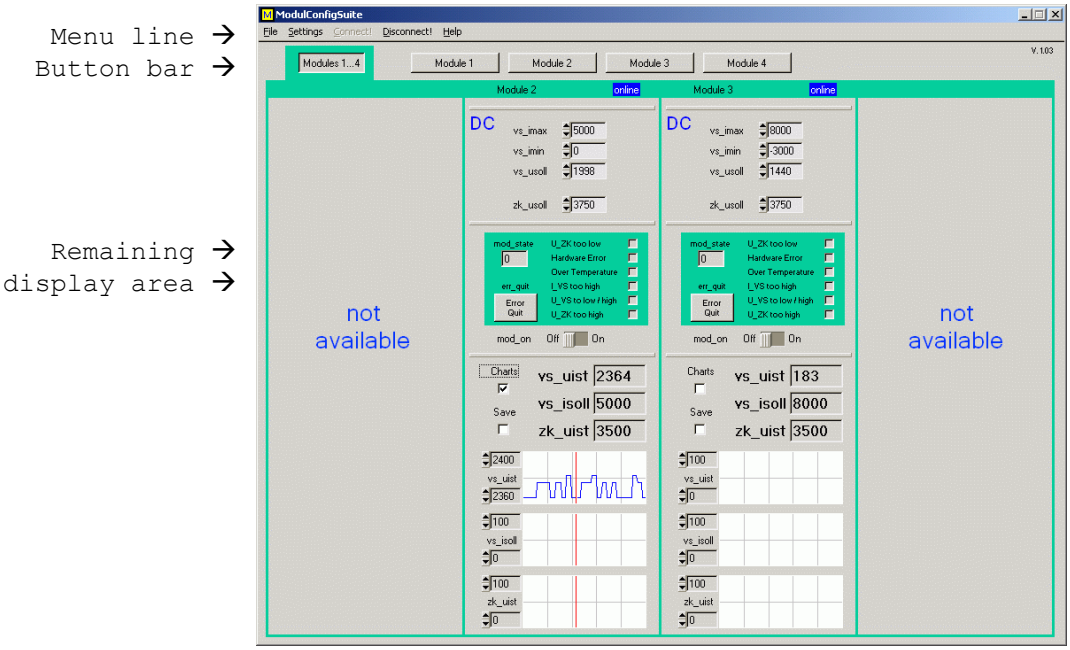

Fig. 6: Constructional design of the software

7.4.2 Single-Mode / Multi-Mode

On principle, the software distinguishes between two modes, the so-called "Single“-mode for the communication with only one single module and the so-called "Multi“-mode for the simultaneous communication with up to 4 modules.

The changeover between the modes is executed by means of the buttons in the upper window area.

Fig. 7: Single-Mode / Module 4

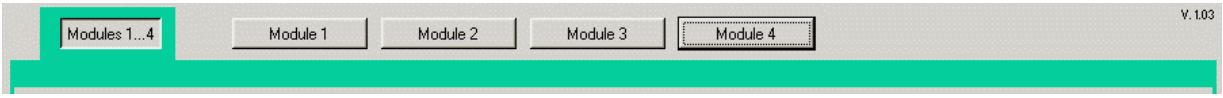

Fig. 8: Multi-Mode

After the start of the software, the Multi-mode is automatically set.

7.4.3 Groupings by Means of Colors / Backgrounds

Owing to the great number of information to be represented at the same time and the diversity of the entries to be processed, the application of different colors for the logical grouping turned out to be advantageous. The legend with

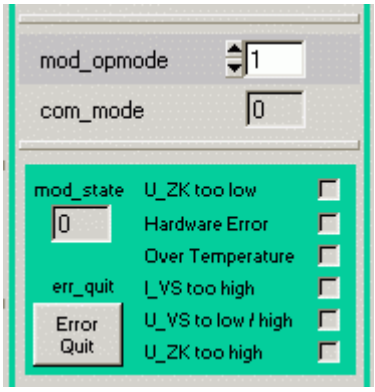

Fig. 9: Example for groupings

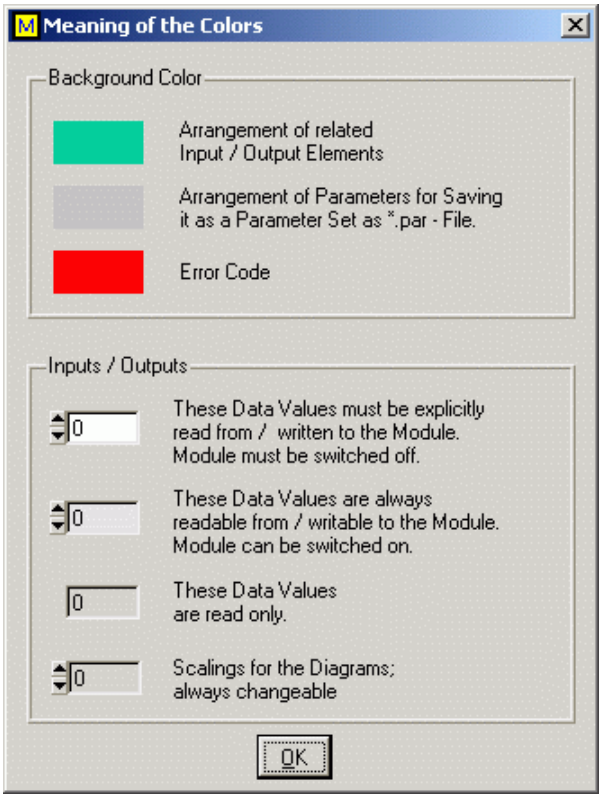
Meaning of the Colors
Background Color
Arrangement of related Input / Output Elements
Arrangement of Parameters for Saving it as a Parameter Set as *.par - File.
Error Code
Inputs / Outputs
These Data Values must be explicitly read from / written to the Module. Module must be switched off.
These Data Values are always readable from / writable to the Module. Module can be switched on.
These Data Values are read only.
Scalings for the Diagrams; always changeable
OK

Fig. 10: Colour legend

the explanation of the colors can be called after the selection of the menu item "Help → Colour Code".

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7.4.4 Meaning of the Error Codes

All data that are transferred (for example, by a click onto one of the buttons "Write Values" in the single-mode) to the module are immediately checked there with regard to their validity. In case of an error, the corresponding error code is entered in a red field directly next to the respective display / entry element.

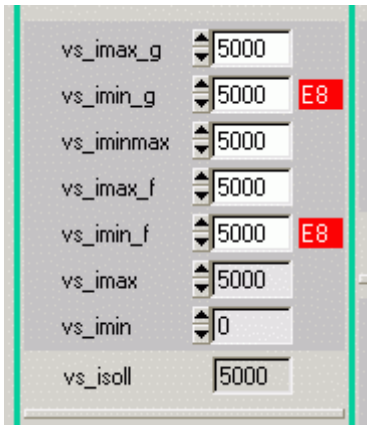

Fig. 11: Example error codes

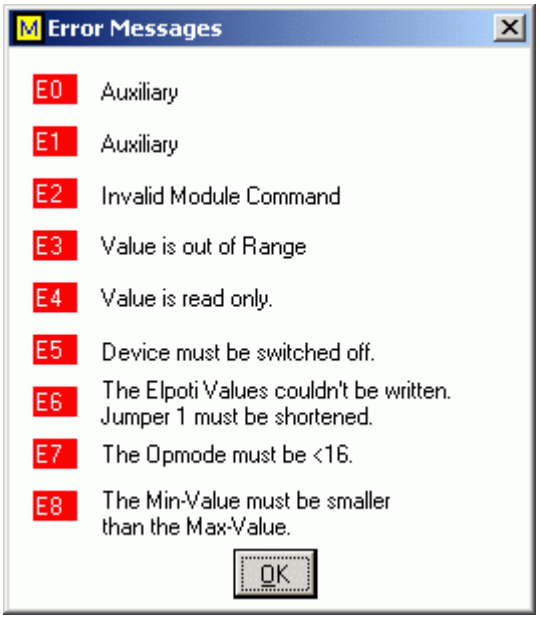
Error Messages
E0 Auxiliary
E1 Auxiliary
E2 Invalid Module Command
E3 Value is out of Range
E4 Value is read only.
E5 Device must be switched off.
E6 The Elpoti Values couldn't be written. Jumper 1 must be shortened.
E7 The Opmode must be <16.
E8 The Min-Value must be smaller than the Max-Value.
OK

Fig. 12: Meaning error codes

A legend with the meaning of the error codes can be called by the selection of the menu item "Help → Error Codes".

7.4.5 Selection and Assignment of the Interfaces

The selection of the interfaces and their assignment to the modules is carried out by the selection of the menu item "Settings → Connection". Depending on the type of the module carrier, there are various possibilities available. In case of the module carrier of the type 1, the communication is executed by means of 4 separate RS232 interfaces (one for every module). The module carrier of the type 2 needs only one RS232 for the communication with all modules (is multiplexed in the module carrier) In case of the module carrier of the type 3 at last, a network interface is available (TCP/IP protocol).

In addition to the assignment of the interfaces, you also have to check off explicitly in the variants 2 and 3 in the configuration dialogue whether communication with the respective module is intended. This offers the possibility to fade-in or fade-out individual modules.

During the selection and assignment of the interfaces, tests are carried through concerning the existence in the PC and/or double bindings.

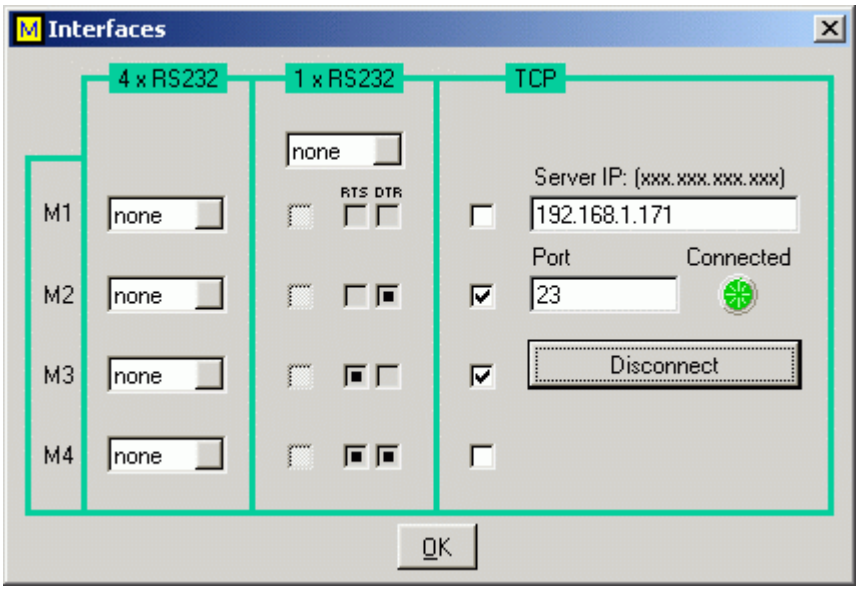

Fig. 13: Assignment of the interfaces

Attention: Only a test of the chosen interfaces and their assignment to the modules is made. The data connection to the modules is only established after the selection of the menu item "Connect!".

7.4.6 Connecting / Disconnecting

By the selection of the menu item "Connect!", it is possible to establish a data connection to the corresponding module (single-mode) and/or to the modules multi-mode). In the single-mode, all data are read-out once completely from the chosen module after the successful establishing of the connection and entered into the respective fields of the screen mask. In the multi-mode, only the relevant data are read-out after the successful establishing of the connection and entered into the respective fields of the screen mask. A selection of the menu item "Disconnect!" cut(s) of the connection(s).

Fig. 14: Information in case of the cutting-off of the connection

The connection is permanently monitored both during the establishing of the connection and during the existing connection. If the establishing of the connection fails and/or the connection is cut-off, a corresponding information is provided.

7.4.7 Storing / Loading of Parameter Sets

In the single-mode, it is possible to durably store parameter sets on the fixed disk and/or to load parameter sets that are stored on the fixed disk. After the calling of the menu items "File → Load Parameter Set" and/or "File → Save Parameter Set"), the corresponding dialogues are called for the loading and storing of files. The parameter files have got a special format that can only be read and write by the ModulConfigSuite. As a standard setting, they have the file extension *.dc.

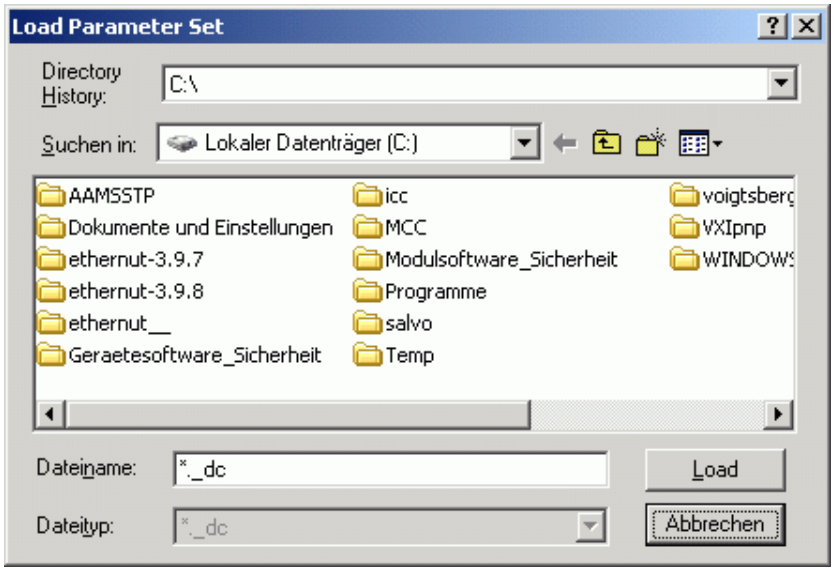

Fig. 15: Dialogue for the loading of parameter set files

When such a file is loaded from the fixed disk, all parameters are immediately entered into the corresponding fields. In the reverse case, only the corresponding fields are read-out for the storing of the parameters in such a file. Only such fields with the respective coloured background are taken into account.

7.4.8 Reading-Out / Parameterizing

All relevant data are automatically read-out from the module and/or the modules during the changeover between the two main modes single-mode and multi-mode (buttons: "Modules 1…4" and "Module 1" … "Module 4") or during the establishing of the connection ("Connect!"). In the single-mode, all data are read-out from the selected module and entered into the corresponding fields of the screen mask, in the multi-mode only the relevant ones. The precondition is in both modes an existing data connection to the respective module and/or to the respective modules.
In addition to that, it is possible in the single-mode to explicitly initiate the reading-out

of the data from the module and/or the storing of data in the module by means of a click onto one of the buttons "Read Values" or "Write Values". Only the data of the respective column (e.g. "DC link") are taken into account during this.

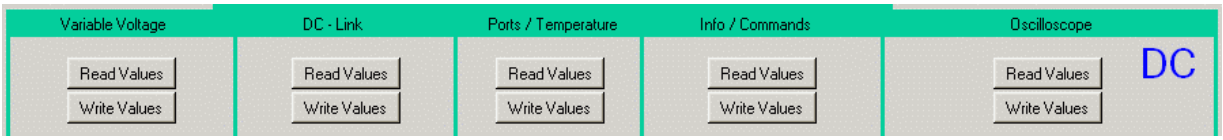

Fig. 16: Buttons for the reading-out / parameterizing in the single-mode

Both in the single-mode and in the multi-mode, some data are immediately transferred after their entry / modification (see colour codes). These are in particular the parameters: vs_imax, vs_imin, vs_usoll and zk_usoll.

7.4.9 Data Visualization / Recording

Both in the single-mode and in the multi-mode, the parameters vs_uist, vs_isoll, zk_uist and mod_state are permanently read-out and visualized with a transfer rate of constantly 10 Hz when the connection exists. If the check boxes "Charts" and "Save" are marked, in addition to that, the three parameters vs_uist, vs_isoll, zk_uist are simultaneously visualized in diagrams and data are stored (data-logging) in the ASCII format.

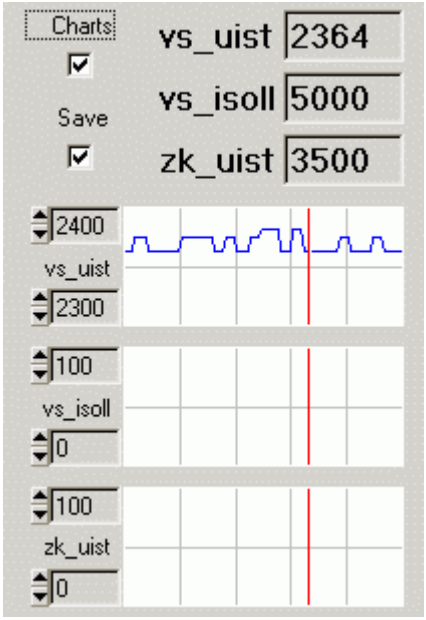

Fig. 17: Dialogue field storing / visualizing

zk_uist	vs_isoll	vs_uist
4011	5710	3069
4011	6810	3069
4011	5710	3069
4011	6730	3069
4011	5550	3069
4011	5095	3069
4011	6340	3069
4011	5315	3069
4011	6260	3069
4011	5785	3069
4011	6575	3069
4011	5710	3069
4011	5865	3069
4011	6655	3069
4011	6340	3069
4011	6810	3069
4011	5785	3069
4011	6025	3069
4011	5080	3069
4011	6025	3069
4011	4860	3069
4011	6730	3069

Fig. 18: Recorded ASCII data

During every new establishing of a connection by means of a click onto "Connect!") and a marked "Save", a new data file (a separate one for every module) in the ASCII

format with the file extension *.asc is automatically generated in the working directory of the ModulConfigSuite. For this purpose, it does not matter whether you are in the single-mode or in the multi-mode. The file names of the generated files are composed of the module code as well as date and time of the beginning of the recording. Consequently, the file name “M3_110406_114231.asc“ designates a data recording of the module 3 that started on 11th April 2006 at 11:42:31 a.m.
For safety reasons, the data are stored only in the corresponding mode (single-/ multi-) respectively in the single-mode only for the module just selected. If, for example, the storing is marked for all 4 modules in the multi-mode, only a storing of the data in the file of the corresponding chosen module is carried out in the single-mode and no (background) storing of the data of all 4 modules is executed. Single-mode and multi-mode store to the same data file of the respective module.

8 Maintenance Service and Repair by the After-Sales Service Division

According to the general terms and conditions of sale and delivery, WARRANTY is furnished for the device provided by the manufacturer. If malfunctions or damages occur at the device during the warranty period warranty is given for according to the terms and conditions of warranty, the manufacturer shall execute the repair or the replacement of defective components after a prior examination.

The manufacturer shall be responsible for the device in its original configuration.

Only the manufacturer shall be authorized to carry out all and any interventions that concern the device, the structure, the software, or the operating cycle of the device or these interventions exclusively require the express prior consent of the manufacturer.

Attention

The environmental conditions agreed in the contract must be met.

The manufacturer shall not be liable for any damages owing to the improper or false utilization of the device as well owing to damages arising from interventions to the device that are not expressly required in the present manual.

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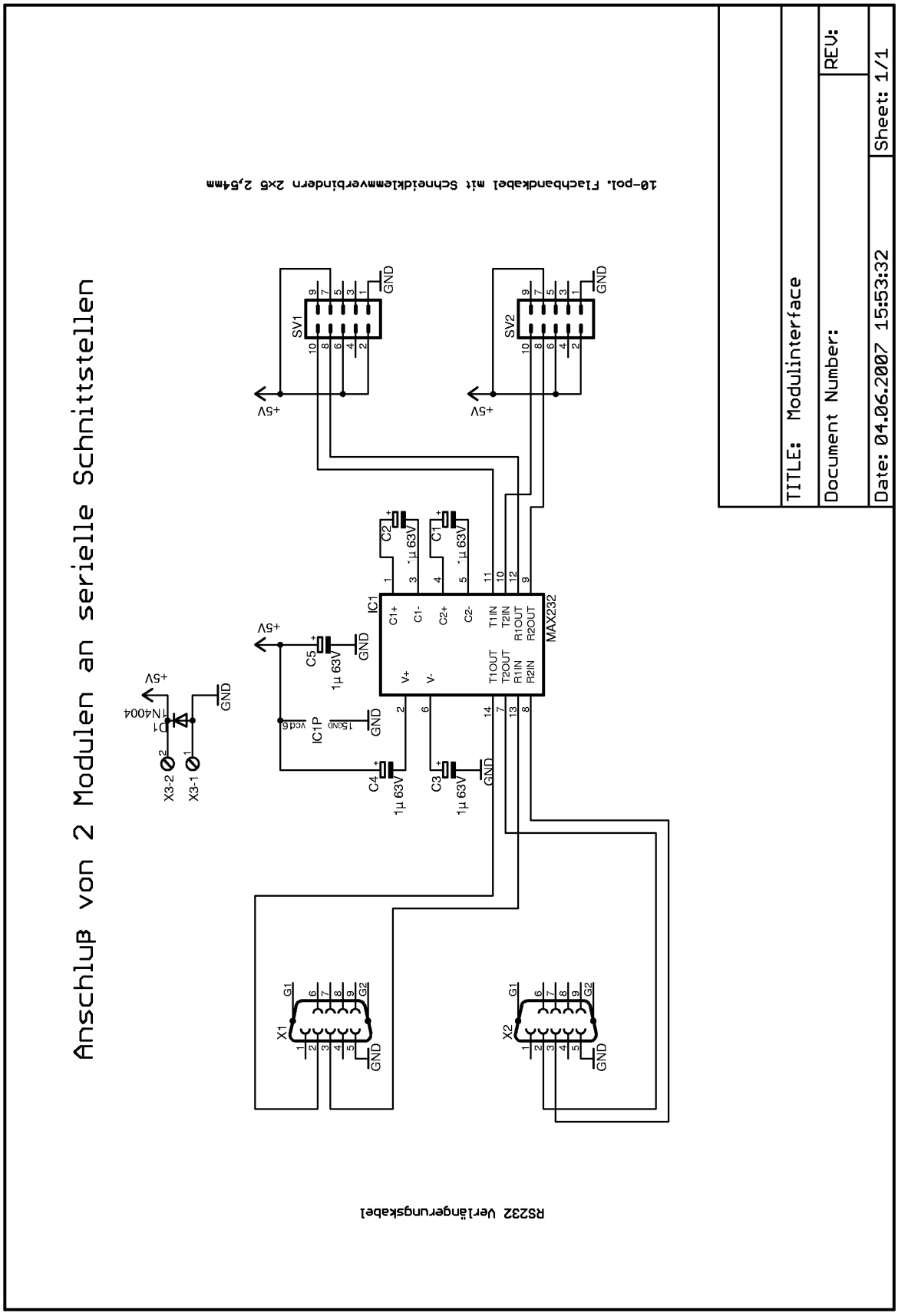
9 Appendix


Anschluß von 2 Modulen an serielle Schnittstellen
10-pol. Flachbandkabel mit Schneidklemmverbindern 2x5 2,54mm
RS232 Verlängerungskabel
TITLE: Modulinterface
Document Number:
REV:
Date: 04.06.2007 15:53:32
Sheet: 1/1
SV1
SV2
+5V
GND
IC1
MAX232
C1+
C1-
C2+
C2-
T1IN
T2IN
R1OUT
R2OUT
V+
V-
T1OUT
T2OUT
R1IN
R2IN
C1
C2
C3
C4
C5
1µ 63V
IC1P
15kΩ
D1
1N4004
X1
X2
X3-1
X3-2
G1
G2